

What is claimed is:

1. A substrate processing apparatus, comprising:
a substrate holder for holding a substrate;
5 a plurality of anodes and cathodes disposed opposite the
substrate held by the substrate holder and arranged alternately
along at least one direction;
a processing liquid supply section for supplying a
processing liquid between the substrate held by the substrate
10 holder and the plurality of anodes and cathodes; and
a power source for applying a voltage between the anodes
and the cathodes.

2. The substrate processing apparatus according to claim
15 1, further comprising:
a drive mechanism for bringing the anodes and the cathodes
close to the substrate held by the substrate holder, and
a rotational drive mechanism for rotating the substrate
held by the substrate holder.

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3. The substrate processing apparatus according to claim
1, wherein the processing liquid contains an electrolyte.

4. The substrate processing apparatus according to claim
25 1, further comprising:

a rectifier for rectifying the waveform of an electric
current to be applied between the anodes and the cathodes to at
least one of an alternating current waveform, a direct current

waveform, a direct current reverse voltage waveform, a pulse waveform, a PR pulse waveform, and a double pulse waveform.

5 5. The substrate processing apparatus according to claim
1, wherein the anodes are arranged over a plane at regular
intervals along orthogonal directions, and each cathode is
disposed approximately in the center between two anodes adjacent
to each other in an oblique direction.

10 6. The substrate processing apparatus according to claim
1, wherein the cathodes are arranged over a plane at regular
intervals along orthogonal directions, and each anode is
disposed approximately in the center between two cathodes
adjacent to each other in an oblique direction.

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7. The substrate processing apparatus according to claim
1, wherein at least one of the anodes and the cathodes are made
of a conductive diamond or lead dioxide.

20 8. The substrate processing apparatus according to claim
1, wherein the distance between the substrate held by the
substrate holder and the anodes differs from the distance between
the substrate held by the substrate holder and the cathodes.

25 9. The substrate processing apparatus according to claim
1, wherein a supply port of the processing liquid supply section
is provided in one of each anode and each cathode, and a suction
port for sucking in the processing liquid supplied from the supply

port is provided in the other one of each anode and each cathode.

10. A substrate processing method, comprising:

bringing a plurality of anodes and cathodes close to a
5 substrate;

supplying a processing liquid between the substrate and
the plurality of anodes and cathodes; and

applying a voltage between the anodes and the cathodes.

10 11. The substrate processing method according to claim 10,
wherein the substrate is rotated while the voltage is applied
between the anodes and the cathodes.

12. The substrate processing method according to claim 10,
15 wherein the processing liquid contains an electrolyte.

13. The substrate processing method according to claim 10,
wherein an electric current having at least one of an alternating
current waveform, a direct current waveform, a direct current
20 reverse voltage waveform, a pulse waveform, a PR pulse waveform,
and a double pulse waveform, is applied between the anodes and
the cathodes.

14. The substrate processing method according to claim 10,
25 wherein the distance between the substrate held by a substrate
holder and the anodes differs from the distance between the
substrate held by the substrate holder and the cathodes.

15. The substrate processing method according to claim 10,
wherein the processing liquid is supplied to the substrate from
a supply port provided in one of each anode and each cathode,
while the processing liquid supplied to the substrate is sucked
5 from a suction port provided in the other one of each anode and
each cathode.

16. A substrate processing apparatus, comprising:
a substrate holder for holding a substrate;
10 a processing head disposed such that it faces the substrate
held by the substrate holder; and
a processing liquid supply section for supplying a
processing liquid between the substrate held by the substrate
holder and the processing head;
15 wherein a plurality of anodes and cathodes, and an
ultrasonic transducer for emitting ultrasonic waves toward the
processing liquid are disposed in the substrate-facing surface
of the processing head.

20 17. The substrate processing apparatus according to claim
16, further comprising:
a relative movement mechanism for moving the processing
head relative to the substrate.

25 18. The substrate processing apparatus according to claim
17, wherein the relative movement mechanism rotates the
processing head.

19. The substrate processing apparatus according to claim 16, further comprising:

a pulse power source for applying a pulse voltage between the anodes and the cathodes.

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20. A substrate processing apparatus, comprising:

a processing liquid supply section for supplying a processing liquid onto a substrate;

a microbubble generator for generating microbubbles in the processing liquid; and

an ultrasonic transducer for emitting ultrasonic waves to the processing liquid containing microbubbles.

21. The substrate processing apparatus according to claim 20, wherein the microbubbles have a diameter of not more than 20 μm , and have an internal pressure of not lower than atmospheric pressure.

22. The substrate processing apparatus according to claim 20, wherein the microbubble generator comprises a two-fluid nozzle, a gas diffuser, a gas/liquid stirrer, or an electrolytic gas generator.

23. The substrate processing apparatus according to claim 20, further comprising:

a substrate holder for holding a substrate; and

a rotating mechanism for rotating the substrate;

wherein the ultrasonic transducer is disposed such that

it faces the substrate held by the substrate holder.

24. The substrate processing apparatus according to claim 23, wherein the ultrasonic transducer has a processing liquid introduction port, and the processing liquid is supplied through the processing liquid introduction port to between the substrate held by the substrate holder and the ultrasonic transducer.

25. The substrate processing apparatus according to claim 20, wherein the frequency of the ultrasonic waves emitted from the ultrasonic transducer is 5 to 100 MHz.

26. A substrate processing apparatus, comprising:
a substrate holder for holding and rotating a substrate;
a rotatable rotary plate disposed opposite to one of the front and back surfaces of the substrate held by the substrate holder at a predetermined distance therefrom; and
a first fluid supply section for supplying a first fluid between the substrate held by the substrate holder and the rotary plate.

27. The substrate processing apparatus according to claim 26, wherein the substrate holder and the rotary plate rotate in opposite directions.

28. The substrate processing apparatus according to claim 26, wherein the first processing fluid is an etching liquid.

29. The substrate processing apparatus according to claim 26, further comprising:

a counter plate disposed opposite to the other one of the front and back surfaces of the substrate held by the substrate holder at a predetermined distance therefrom, and

a second fluid supply section for supplying a second processing fluid between the substrate held by the substrate holder and the counter plate.

30. The substrate processing apparatus according to claim 29, wherein the counter plate is rotatable.

31. The substrate processing apparatus according to claim 30, wherein the counter plate rotates in a direction opposite to the rotating direction of the substrate holder.

32. The substrate processing apparatus according to claim 29, wherein the second processing fluid is an etching liquid.

33. The substrate processing apparatus according to claim 29, wherein the counter plate is rotatable.